Climate Policy and Profit Efficiency

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Abstract

As widely recognized, human mankind stands before the most challenging problem of preventing anthropogenic climate change. As a response to this, the European Union advocates an ambitious climate policy mix. However, there is no consensus concerning the impact of stringent environmental policy on firms' competitiveness and profitability. From the traditional 'static' point of view there are productivity losses to be expected. On the other hand, the so called Porter hypothesis suggests the opposite; i.e., due to 'dynamic' effects, ambitious climate and energy policies within the EU could actually be beneficial to firms in terms of enhanced profitability and competitiveness. Based on Sweden's manufacturing industry, our main purpose is to specifically assess the impact of the CO2 tax scheme of Sweden on firms' profit efficiency. The empirical methodology is based on stochastic frontier estimations and, in general, the results suggest we can neither reject nor confirm the Porter hypothesis across industry sectors. Therefore, we do not generally confirm the argument of stringent environmental policies having positive dynamic effects that potentially offset costs related to environmental policy.

JEL-classification: D20, H23, Q52, Q55.

Keywords: CO2 tax, efficiency, stochastic frontier analysis, Swedish industry.

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1. Introduction

It is widely recognized that anthropogenic climate change is one of the most challenging and urgent global problems to be solved. For example, the European Union advocates an ambitious climate policy strategy to make a difference (see, e.g., EU, 2008), and in a worldwide perspective the EU has the intention of setting a good example. In particular, this has involved pursuing energy and climate policies that cut greenhouse gas emissions. For instance, a price on CO_2 has been introduced by the EU Emission Trading System (ETS) in 2005. The ETS will comprise all major carbon dioxide (CO_2) emitting sectors, however, the sectors outside the ETS will not be exempted from climate and energy policy; for these non-trading sectors, raised CO_2 taxes is an alternative. In this respect, Sweden is a leading country as it was one of the first nations to introduce a CO_2 tax for households and selected industry sectors in 1991. By international comparison, the CO_2 tax in Sweden has been maintained at a significant level ever since.

One common argument against environmental regulation is that they may, in addition to simply increase costs, hamper productivity and competitiveness among firms, and therefore further lower profits. Viewed in this perspective, high environmental ambitions of EU and Sweden may have far-reaching negative effects on regulated firms' possibilities of competing on international markets. On the other hand, the well-known Porter hypothesis (Porter, 1991; Porter and van der Linde, 1995) claims that introducing, or strengthening, the 'right kind' of environmental regulation (e.g., in principle taxes and tradable permits) will induce productivity gains and reduce inefficiencies, leading to increased competitiveness and profits compared to countries with lower environmental ambitions. As a result environmental policy could be costless and, consequently, by being a 'first mover', the EU and Sweden could actually benefit more than they loose from its climate mitigation endeavors. Based on the case of Sweden, this paper addresses this issue by studying the CO_2 tax scheme and its effects on firms' competitiveness and profits.

The main purpose of this paper is to assess the contemporary and dynamic effects of the Swedish CO_2 tax scheme on firm profit efficiency in the manufacturing industry during the period 1990 to 2004. The empirical approach consists of obtaining conditional profit efficiency scores by using a stochastic profit frontier approach. In this particular case we address efficiency in managing energy input use, i.e., we assume that firms may be more or less profit efficient depending on how well energy is managed in the production process. Efficiency is allowed to depend on both contemporary and lagged CO_2 tax, which enables us to test for immediate and dynamic effects of CO_2 taxation on profit efficiency.

The literature on the Porter hypothesis and the argued effects of environmental regulation on profitability/competitiveness is now quite extensive. In a recent and comprehensive review, Brännlund and Lundgren (2009) conclude that there is no general evidence, neither for nor against the Porter hypothesis. It is also evident that there are few studies that directly address the profit perspective or even the 'right kind' of regulations. Also, as far as we know, there is no study that takes dynamics into account (lagged effects of the CO_2 tax) when analyzing the relationship between climate policy, such as the Swedish CO_2 tax, and firm profit efficiency. Therefore, this paper contributes importantly to the literature on the subject, which is made possible by a unique data set that includes total CO_2 taxes actually paid at firm level in Swedish industry. If the Porter hypothesis is relevant in this case, an appealing policy implication is that firm productivity and competitiveness may be improved with relatively modest efforts (i.e. by simply raising the tax). Specifically, if profit inefficiency is confirmed, it means that individual firms' actual profits are low in comparison to a potentially attainable profit frontier. Hence, there are profit improvements to be made among these firms through better management of the energy input, without actally investing in any new technology; it is simply about using current technology and energy input resources more efficiently. If profit inefficiency is established, and if CO_2 taxation has a significant positive effect on profit efficiency, then the CO_2 tax schemes may constitute a policy that accomplishes both pollution reductions *and* profit improvements.

The paper is structured as follows. In Section 2 the Porter hypothesis is described, and earlier literature on the subject is discussed. Section 3 presents the empirical framework; a stochastic frontier approach is used to estimate profit efficiency conditional on CO_2 taxation. Section 4 presents the data, and in Section 5 the empirical results are given. Finally, Section 6 offers a conclusion.

2. Climate policy without cost?

2.1 CO_2 taxation in Swedish industry

Regarding CO_2 taxation in Sweden, a historical view and detailed discussion is provided in Brännlund (2009). Sweden was one of the first nations to introduce a CO_2 tax for households and selected industry sectors in 1991. By international comparison, the CO_2 tax has been maintained at a significant level ever since. However, the tax burden gradually shifted over to the non-industry sector over the years. In fact, the Swedish CO_2 tax system is complex and characterized by exceptions and exemptions (see Brännlund, 2009). One argument for not imposing a too heavy burden on the industry sector is that the CO_2 tax in Sweden cannot deviate too much from taxes in other countries, as it would jeopardize the competitiveness of Swedish firms on international markets. Nevertheless, the effective tax rate for industry firms is not negligible; during the period 1991-2004 it was on average 0.11 SEK/kg CO_2 (about 10 EURO/ton) and it varied across years, sectors, and firms.

The argument that the Swedish CO_2 tax scheme should not deviate too much from tax policies in other countries contradicts the Porter hypothesis, which argues that environmental regulations of the 'right kind' lead to increased competitiveness. This hypothesis is discussed below.

2.2 The Porter hypothesis

A most widely used argument against stringent environmental regulation is that firms are forced to reduce production, or make certain investments that crowd out other more productive investments. Consequently, productivity levels and productivity growth are hampered, and therefore also competitiveness and profits. This means that environmental policy apprehends as causing the firms substantial costs. However, the Harvard Professor Michael E. Porter questioned these types of arguments (Porter, 1991). His arguments in favor of stringent environmental regulation of the 'right kind', such as pollution taxes, tradable permits, and deposit-refund schemes (Porter and van der Linde. 1995, p. 111), have later on become to be known as the Porter hypothesis. The hypothesis is in detail outlined in Porter and van der Linde (1995), where the most essential point made is that the relationship between environmental regulation and firm competitiveness should be viewed from a dynamic point of view and not from a static point of view. The dynamic view allows for firm adjustments over time that, e.g., incorporate process and technology development that is positive for firm performance. Hence, profit is increased, and is ultimately increased to such an extent that the cost of achieving the profit increase is offset. Accordingly, given that regulations have positive effects on the environment, the Porter hypothesis may be seen as a “win-win” hypothesis. In other words, improved environmental status comes with seemingly no costs.

The “win-win” outcome is sometimes referred to as a “strong” Porter effect. In Brännlund and Lundgren (2009, p. 9), a strong Porter effect is defined as originating from environmental policy-induced productivity gains that are generating additional profits that, at least, compensate for the costs of attaining the productivity gains. On the other hand, a “weak” Porter effect refers to the case when the cost is not fully compensated. In this paper we particularly address the Swedish climate policy and whether there are any effects on firm profit in general, strong or weak, in terms of affecting profit efficiency. Hereafter, the Porter hypothesis is formally considered from this perspective.

According to Porter and van der Linde (1995), “win-win” situations arise because there are dynamic effects evolving over time. It is too narrow to regard effects of environmental policy from a static point of view. The static view of environmental taxation is illustrated in Figure 1.

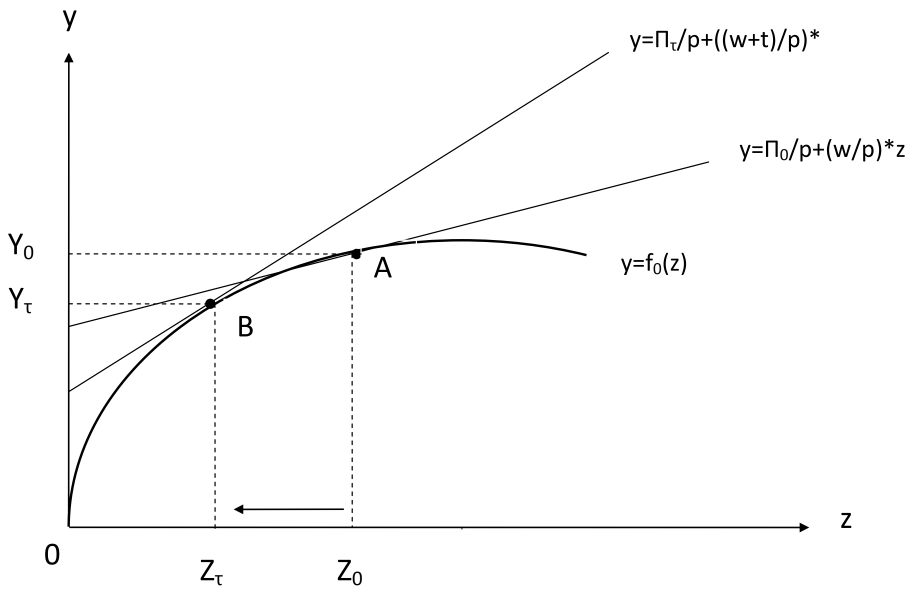

Figure 1. Environmental taxation – Static effect on production.

Assume that a profit-maximizing firm produces a market product, y, by using a single input factor, x. The product and factor price is p and w, respectively. Then the firm profit objective to be maximized is $\prod_0 = py - wx$. Furthermore, assume that the use of input give rise to emissions of some pollutant according to $\alpha x = z$, $\alpha > 0$. Accordingly, firm production may be described as $y = f_0(z)$. Given the relative price, w/p, i.e., the slope of the price line, $\prod_0$, the profit maximizing firm will produce the amount y_0, when not being environmentally regulated. Consequently, the production will generate the emission level z_0.

Next, assume that the regulating authority imposes an unit tax on emissions, τ, which means that the production cost increases to $(w+\tau)x$, or $(w+\tau)z/\alpha$. Given the technology in use, $f_0(z)$, the profit maximizing firm adjusts as reflected by the altered slope of the price line from w/p to $(w+\tau)/p$. This will reduce the emission level to z_τ, as desired by the authority, but also will the production level be lowered to y_τ. Consequently, the firm profit decreases from $\prod_0$ to $\prod_\tau$ due to environmental taxation. This is a static view of tax effects on firm performance.

However, as argued by the Porter hypothesis, there are circumstances that allow for environmental regulations of the 'right kind', e.g., a tax, to increase profits. Such a circumstance is, e.g., when resource inefficiencies are present pre-taxation, or when tax rates are low (Porter and van der Linde, 1995, p. 99). To illustrate the Porter hypothesis and accounting for variation in resource efficiency, we therefore start out from the literature of productive efficiency.[2] This allows us to view firm performance development by considering not only technological change, but also efficiency change. This is illustrated in Figure 2, where the firm due to management inefficiency is operating at point C, and is obviously not maximizing the profit.

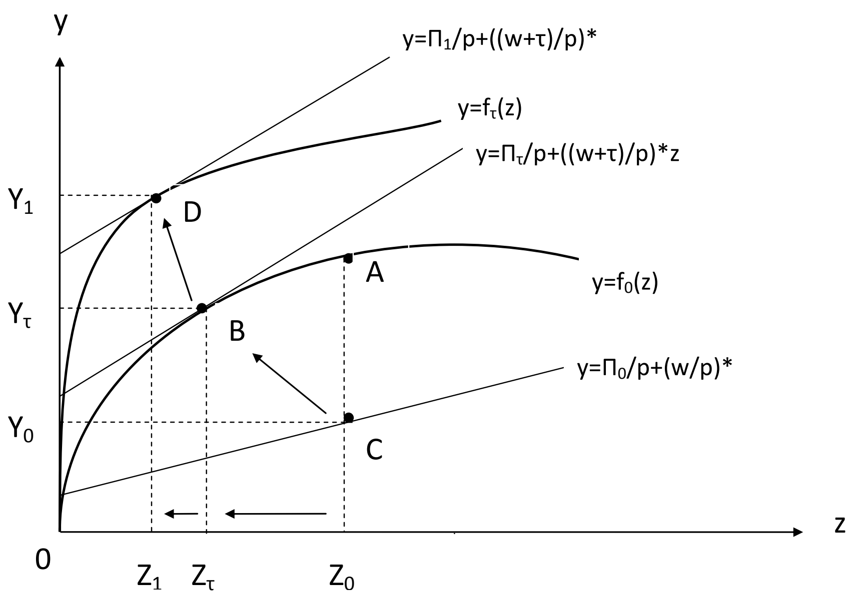

Figure 2. Environmental taxation – Dynamic Porter effect on production.

[2] See, e.g., Coelli et al., (2005), Färe and Primont (1995), and Fried et al. (2008).

Again, assume that the regulatory authority imposes an emission tax, τ . Then, according to the Porter hypothesis, the tax burden will make the firm aware of inefficiencies and, hence, the firm will begin to use each input unit more efficiently to maximize profit. Before the tax is imposed, improved efficiency in line with profit maximization would be illustrated by the firm moving its operation from point C to point A. However, as the imposed tax changes the relative price between the produced market product and emissions, the firm adjusts further to point B. Compared to operating at point C the production is increased from y_0 to y_τ, at the same time as emissions are reduced from z_0 to z_τ. Obviously, if a firm is operating inefficiently when not being environmentally regulated, imposing a tax will not only cause the firm costs, but also may induce additional revenues. Therefore, it is not obvious that imposing an emission tax will reduce the firm profit. As illustrated in Figure 2, and as the Porter hypothesis suggests, profit increases from $\prod_0$ to $\prod_\tau$ (which is the opposite compared to the case illustrated in Figure 1).[3]

However, taking a traditional standpoint, the positive effect on firm profit from moving from point C to point B would not be regarded as a dynamic effect of environmental taxation, as no technological change actually has occurred from one period to another. But, this particular movement does not necessarily have to occur instantaneously. Firms may adjust stepwise during several periods after the tax having been imposed. Hence, efficiency may improve over time. As such taxes may be regarded as having dynamic effects on firm efficiency.

Finally, technological change is manifested by shifts in the frontier technology, which may be seen as results of environmental taxation stimulating innovative behavior that leads to

[3] However, whether profits actually increase due to firms being environmentally taxed is entirely a task for empirical research.

development of new processes. In Figure 2, this is illustrated by the technology shift from $y = f_0(z)$ to $y = f_\tau(z)$. Given the relative price $(w+\tau)/p$, the profit maximizing firm will then operate at point D. Production increases further to y_1, emissions are reduced further to z_1 and, accordingly, the profit increases to Π_1.

In this paper we analyze the Porter hypothesis by investigating whether there is a positive relationship between CO_2 taxation and profit efficiency, which in Figure 2 is illustrated by the distance between C and B.

2.3 Earlier literature

A recent review by Brännlund and Lundgren (2009) structures the international literature and put things into perspective. Their main conclusion is that there is no general empirical evidence in favor of the Porter hypothesis, but neither is there any general evidence against the hypothesis. However, empirical research specifically focusing on the effects of environmental policy on productivity growth tends to show either negative effects or no effects at all. Furthermore, regarding studies on environmental policy and effects on firm profits, a study that somewhat distinguishes from the others, in terms of model approach adopted, is Brännlund and Lundgren (2010). Using a factor demand system, they study the effects of the Swedish CO_2 tax regime on technological progress and profit development in the Swedish manufacturing industry, corresponding to a shift in the price line from Π_τ to Π_1 in Figure 2. The results show a 'reversed' Porter effect, specifically for energy intensive industries. The present study uses partly the same data set but from a different perspective; we look specifically on both the contemporary and dynamic effects of a CO_2 tax on profit (in)efficiency, i.e., a shift from Π_0 to Π_τ.

Important to notice is that the empirical studies directing the Porter hypothesis are in general missing the most crucial argument of the hypothesis, namely the dynamic perspective. Managi et al. (2005) and Lanoie et al. (2008) are, however, two studies that consider dynamics in some sense. Studying the oil and gas production in the Gulf of Mexico, at the field level, during a 28-year period, Managi et al. (2005) first apply Data Envelopment Analysis (DEA) to measure various components of Malmquist output-oriented Total Factor Productivity (TFP). In a second step they apply econometrics to test the Porter hypothesis. This involves allowing for dynamic effects of environmental stringency by incorporating lag structures. Environmental stringency is proxied by the cost of complying with environmental regulations. Their results show no significant relationship between environmental stringency and productivity change, or technological change (which could be exemplified by the movement from point B to point D in Figure 2), when only modeling market output (excluding bad outputs). However, whether this is to be interpreted as being non-supportive to the standard Porter hypothesis on market outputs is less clear as it, by Managi et al. (2005), appears that environmental regulations imposed on offshore oil and gas production have historically been in terms of command-and-control. Generally, Porter and van der Linde (1995) state that environmental policy should not be directed at, e.g., specifying specific technologies by command-and-control.[4]

Performing an empirical analysis on 17 Quebec manufacturing sectors during 1985-1994, Lanoie et al. (2008) first calculate a Törnquist TFP-index and in a second step TFP is regressed on a set of explanatory variables, e.g., environmental stringency. As a proxy for environmental stringency investment in pollution-control is used. Furthermore, to test for dynamic effects the pollution-control investment variable is lagged. Their results show that

[4]According to Porter and van der Linde (1995, p. 110, Footnote 13), command-and-control should be seen as a last resort.

there are positive dynamic effects on TFP (which could be exemplified by the movement from point B to point D in Figure 2). However, whether this is to be interpreted as being in favor of the Porter hypothesis is doubtful. The pollution-control variable used as a proxy for environmental regulation stringency mainly incorporate “end-of-pipe” equipment, which Porter and van der Linde (1995, p. 111) not really recommend.

A similar approach, and accounting for dynamics, is adopted in Broberg et al. (2010). They study the effect of environmental protection investments on total firm efficiency in five Swedish manufacturing sectors during the period 1999-2004.[5,6], Total efficiency scores are first estimated using a parametric stochastic frontier production function approach. Then, in a second step, the efficiency scores are used as the dependent variable in linear random effects regression analyzes, where investment in pollution control and pollution prevention, together with some control variables, are included as independent variables. Investment in pollution prevention is clearly recommended by Porter and van der Linde (1995). However, the results in Broberg et al. (2010) show no general support for the Porter hypothesis and argued dynamic effects of environmental regulation on productivity.

Finally, it is obvious that there are only a few studies on the Porter hypothesis that directs environmental policy and its effects on firm profit, and also account for dynamics. Additionally, to our best knowledge, there is no study on effects of environmental regulation on profit efficiency (referring to price line shift from $\prod_0$ to $\prod_\tau$ in Figure 2). In this paper such a study is provided, which is, similarly to the Broberg et al. (2010) study, based on a stochastic frontier approach. This is the topic of the next section.

[5] The components of total efficiency are technical efficiency and management efficiency. The effects on technical and management efficiency are not isolated.
[6] The sectors are Wood and wood products, Pulp and paper, Chemicals, Rubber and plastic, and Basic metals.

3. Stochastic frontier analysis

To test whether the CO_2 tax regime in Sweden has had any effects on firms' profit efficiency we use stochastic frontier analysis,[7] which was suggested by Battese and Coelli, (1992, 1995), and Coelli (1996). Furthermore, the estimating procedure may be seen as being composed of two parts performed in chorus. The first part refers to obtaining profit efficiency scores by estimating stochastic profit functions. The second part refers to the actual tests, where the profit efficiency scores are dependent on a CO_2 tax variable and a set of control variables. In purpose of catching dynamic effects of CO_2 taxation, the tax variable is also lagged, following Managi et al. (2005) and Lanoie et al. (2008). As suggested in Battese and Coelli (1995), the two parts of the estimating procedure are conducted simultaneously. Recent studies using the simultaneous approach, however estimating production functions and not profit functions, are, e.g., van der Vlist et al. (2007), and Shadbegian and Gray (2006).

3.1 Theoretical outline

The production function approach is commonly used when estimating frontiers; however, here we instead base our analysis on a stochastic frontier profit function approach. When estimating production functions directly, there are some econometrical issues (Kumbhakar, 2001). For instance, as firms choose input quantities in production in purpose of maximizing profits, the assumption of regressors being exogenously given is violated. This will lead to inconsistent parameter and technical efficiency estimates. However, this problem is avoided when estimating profit functions as output and input prices are (assumed) exogenous to the firm's optimizing problem.

[7] For an introduction and a general discussion of stochastic frontier estimations, see, e.g., Coelli et al. (2005), or Kumbhakar and Lovell (2000).

The profit efficiency approach adopted is based on Kumbhakar (2001), and may be described as follows. First, the underlying production function may be expressed as

$$y = f(x)e^{-u}, \qquad u \geq 0, \; 0 < e^{-u} \leq 1 \tag{1}$$

where y is produced market output, x is a vector of inputs used in production, and u is technical efficiency. Technical efficiency is in this case referred to as being output-oriented, i.e., it says something about how much output can be increased, holding input quantities constant.

Assuming that technical inefficiency exists, i.e., $u > 0$, the profit function corresponding to equation (1) may be written as

$$\pi(w, p, u) = \pi(w, pe^{-u}) \tag{2}$$

which hereafter is named as the observed profit function. As e^{-u} introduces profit inefficiency into the model, the expression in equation (2) may be rewritten as

$$\pi(w, pe^{-u}) = \pi(w, p) \cdot h(w, p, u) \tag{3}$$

where $\pi(w, p)$ is the maximized profit function and $h(w, p, u)$ is profit efficiency. By assuming the underlying production function, $f(x)$, being homogenous of degree r, profit efficiency is assumed to not depend on prices, (w, p), but only on output-oriented technical efficiency, u. Accordingly, profit efficiency is defined as

$$h(u) = \frac{\pi(w, pe^{-u})}{\pi(w, p)} \leq 1 \quad (4)$$

where the maximized profit function constitute the profit frontier. Hence, profit inefficiency indicates that there is profit loss attributed to output technical inefficiency, and it is interpreted in terms of percentage loss. Only if $u = 0$ profit efficiency is $h(u) = 1$.

Based on frontier production function estimations, as suggested by Battese and Coelli (1992, 1995), and Coelli (1996), the stochastic profit frontier model may be expressed as

$$\ell n(\pi_{kt}(w, pe^{-u})) = \ell n(g_{kt})\beta + v_{kt} - u_{kt}^{\pi} \quad (5)$$

where $\pi_{kt}(\cdot)$ is the observed profit of firm k in year t, and $g_{kt} = [p^1,..., p^M, w^1,..., w^N]$ is a vector of output and input prices. The error term is divided into two components v_{kt} and u_{kt}^{π}. The component v_{kt} arises from random chocks and measurement errors, and these influences are $iid\ N(0, \sigma_v^2)$ and independent of u_{kt}^{π}, which is a nonnegative random variable that captures profit inefficiency, and is independently (not identically) distributed such that it is obtained by truncation at zero of $N(z_{kt}\delta, \sigma_u^2)$. Finally, σ_v^2 and σ_u^2 are replaced with $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / (\sigma_v^2 + \sigma_u^2)$.[8]

In all, the profit inefficiency in equation (4) is defined as

[8] To test whether there is any profit inefficiency at all a significance test of the γ estimate can be run (see Coelli, 1996, p. 6).

$$u_{kt}^{\pi} = z_{kt}\delta + \upsilon_{kt} \tag{6}$$

where z_{kt} is a vector of variables that are exogenously given to the firms' production processes, and δ is a vector of parameters to be estimated. The random variable, υ_{kt} ~ $N(0,\sigma_{\upsilon}^{2})$, is truncated by the variable truncation point $-z_{kt}\delta = \upsilon_{kt} - u_{kt}^{\pi}$ (see equation (6)).

Profit efficiency is then defined as

$$PE_{kt} = \exp\left(-u_{kt}^{\pi}\right) = \exp\left(-z_{kt}\delta - \upsilon_{kt}\right), \tag{7}$$

which shows that the smaller the nonnegative inefficiency variable, u_{kt}^{π}, the more profit efficient is firm k. Hence, when $u_{kt}^{\pi} = 0$ then $PE_{kt} = 1$ and the firm is operating efficiently on the profit frontier.

The expressions in equation (6) and (7) constitute the basis of the test procedures to be conducted in this paper.

3.2 Empirical approach

3.2.1 The profit frontier

The empirical approach taken includes the specification of the profit function in equation (5), which is parameterized as a Cobb-Douglas log function specification.[9] It is assumed that the firms are producing one market product by using the input factors capital (*K*), labor (*L*), electricity (*E*), and fossil fuel (*F*). In purpose of focusing on technical efficiency related to energy inputs, the profit function is specified as a restricted profit function. This means that capital and labor are modeled as being fixed in the short run. Furthermore, the function is normalized in terms of the output price in purpose of imposing the property of being homogenous in prices. Hence, the stochastic restricted normalized profit function is specified and estimated on the capital and labor input factors, *K* and *L*, on prices of energy input factors, w_E, w_F, and the price of the produced product, p, as follows:[10]

$$\ell n(\pi/p) \tag{8}$$

$$= \alpha_0 + \alpha_K \ell n(K_{kt}) + \alpha_L \ell n(L_{kt}) + \alpha_E \ell n(\frac{w_{E,kt}}{p_{kt}e^{-u}}) + \alpha_F \ell n(\frac{w_{F,kt}}{p_{kt}e^{-u}}) + \sum_{q=1}^{Q-1} \alpha_q D_{size}^q + \alpha_\tau f(t)$$

$$+ v_{kt} - u_{kt}^{\pi}$$

where the normalization imposes the parameter restriction $\alpha_E + \alpha_F + \alpha_P = 1$. The function is convex and continuous in prices, non-decreasing in p and non-increasing in w, and concave and continuous in fixed input factors (Bergman, 1997).[11] The estimated parameters of the fixed factors are therefore expected to have a positive sign. Furthermore, to account for size

[9] More flexible profit function specifications were tested, such as the translog, but the Cobb-Douglas performed better in terms of model convergence and economically reasonable parameter estimates.

[10] In the case of a underlying Cobb-Douglas production function that is homogeneous, the relationship between profit efficiency and output technical efficiency may be expressed as $\ell nh(w,p,u) = 1/(1-r)\cdot u$, where r is the degree of homogeneity. The difference between profit efficiency and output technical efficiency is then defined as a scale effect (Kumbhakar, 2001, footnote 9, p. 5).

[11] See Chand and Kaul (1986) for a discussion of the restricted normalized Cobb-Douglas profit function.

effects on profit, size dummies, D_{size}^{q}, are included. For this purpose, firms are divided into size quartiles, $q = 1,...,4$, based on number of employees. This will introduce size specific profit frontiers, which via the intercept differ in levels. That is, all firms belonging to a certain size is compared to the same frontier level. Finally, technological development is modeled as being Hicks neutral by $\alpha_{\tau} f(t)$, for $t = 1,...,T$ periods. Specifically, technological development shifts the intercept of the profit function accordingly to $f(t) = \alpha_{\tau 1} t + \alpha_{\tau 2} t^2 + \alpha_{\tau 3} t^3$.

3.2.2 The profit efficiency model

The main purpose of this paper is to test whether the CO_2 tax regime in Sweden has had any effects on firms' profit efficiency. Therefore, the expression in equation (7) also needs to be explicitly specified, meaning that relevant explanatory z_{kt} variables need to be identified. Specifically, the empirical profit efficiency effects model reads as follows:

$$-u_{kt} = \delta_0 + \delta_1 tax(CO_2)_{kt} + \delta_2 tax(CO_2)_{k,lag} + \delta_3 Size_{kt} + \delta_t Trend + \upsilon_{kt} \quad (9)$$

which, following Battese and Coelli (1992, 1995), and Coelli (1996), is estimated simultaneously with equation (8). The explanatory variables are the following; $tax(CO2)_{kt}$ captures the contemporaneous (static) effect of the CO_2 tax on profit efficiency, and $tax(CO2)_{k,lag}$ captures the dynamic effects. The latter variable is constructed as a moving average of a three lag structure, i.e., $tax(CO_2)_{k,lag} = (tax(CO_2)_{kt-1} + tax(CO_2)_{kt-2} + tax(CO_2)_{kt-3})$ /3. Furthermore, "*Size*" is a variable that accounts for size effects within each size quartile and is a function of labor stock. Finally, a trend variable is included to account for time effects on profit efficiency, e.g., booms, recessions, and other time specific events that are not related to

Hicks neutral technological development in the profit function. The parameters to be estimated are $\delta_0, \delta_1, \delta_2, \delta_3$, and δ_t. T-tests on the estimated parameters of contemporaneous and dynamic effects of CO_2 taxation, $\hat{\delta}_1$ and $\hat{\delta}_2$, respectively, are then performed in order to evaluate the validity of the Porter hypothesis. Based on the hypothesis suggesting that there are positive dynamic effects of environmental regulation on profits, the $\hat{\delta}_2$ estimate is expected to take a positive sign. On the other hand, the $\hat{\delta}_1$ estimate is to be viewed as capturing static effects of CO_2 taxation, and Porter and van der Linde (1995) see the traditional neoclassical view on environmental regulation as being static and too narrow. Therefore, it seems natural to not exclude the possibility of a negative sign for $\hat{\delta}_1$.

3.2.3 An alternative approach

The empirical model outlined above follows a quite common procedure concerning how quasi-fixed variables are entered into the model. That is, in our case, quasi-fixed capital (*K*) and Labor (*L*) are modeled as arguments in the profit function (equation (8)). However, an alternative approach would be to include these variables as arguments in the inefficiency function (equation (9)). As brought forward by Lovell (1993, p. 53) it is not always obvious what variables belong to the first stage of the estimating procedure, i.e., equation (8), and what variables belong in the second stage, i.e., equation (9). He suggest, amongst others, that fixed variables are to be regarded as variables that explain the distribution of the (in)efficiency scores. Hence, we also present results from estimations where the capital (*K*) and labor (*L*) variables are included as arguments in equation (9), instead of in equation (8). These slightly different approaches will also provide us with a robustness test of the estimates.

4. Data

Table 1 provides an overview of the different sectors in the data set available. The data contains information from all firms in the manufacturing industry in Sweden (SNI10-37).

Table 1. Swedish manufacturing industry data.

SNI (branch code)	Description
10, 11, 131-132, 14	Mining
15-16	Food
17-19	Textile
201-205	Wood
2111-2112, 2121-2124	Pulp and paper
22	Printing
231-233, 24	Chemical
251-252	Rubber and plastic
261-268	Stone and mineral
27-28	Iron and steel
29	Machinery
30-33	Electro
34	Motor vehicles

Notes: Industry branch code classification of Swedish manufacturing (SNI) according to Statistics Sweden.

The data set is a firm level balanced panel covering the years 1990 to 2004.[12] It contains firms with more than five employees and includes data on output (sales), value added, input data on (quantities and values) labor, electricity and fuels, and gross investment (machinery and buildings). Capital stocks are calculated residually from other data available; value added,

[12] Brännlund and Lundgren (2010) use an unbalanced panel containing data on the same variables and from same sectors as in the present study. The balanced panel used here is a sub-set of their data set which contains all firms that have 'survived' the whole period, 1990-2004.

cost of capital, and salary paid to employees.[13] Assuming that value added is compensation to labor and capital (salaries plus capital costs), we can extract the capital stock residually. The data also contains detailed information on emissions of CO_2 and total payment of CO_2 tax for each firm. This enables us to construct a variable for "effective" CO_2 tax, which varies considerably across firms, sectors, and over time.

Output price indices[14] are sector specific, and firm specific input prices can be calculated from the costs for labor, electricity, and fuels. The calculation of the price of capital is based on national and industry based indices, respectively, which seems plausible considering that firms have limited opportunities to affect the prices for capital (global market) significantly.

Some descriptive can be found in Table 2 and Figure 3. As mentioned above, the CO_2 tax varies considerably across sectors ranging from about 0.04 SEK/kg in the wood product sector to almost 0.15 SEK/kg in the Food sector. From Figure 3 it is evident that there is no particular pattern or relationship between the cost shares of energy or fuels and the actual CO_2 tax paid by firms. In other words, high use of CO_2 emitting inputs does not necessarily mean that the payments of CO_2 tax per unit emitted are also high.

[13] Assuming that value added is $VA = p_L L + p_K K$, i.e., compensation to primary factors of production.
[14] Collected from Statistics Sweden, see producer price index section at the website www.scb.se.

Table 2. Descriptive statistics. Mean values 1990-2004.

	Sector					
Variable	Mining	Food	Textile	Wood	Pulp/paper	Printing
Captal stock (TSEK)	524777 (1365816)	259549 (509303)	97186 (181651)	88450 (157760)	775387 (1511305)	63998 (102548)
Employees (number of)	275 (472)	208 (227)	148 (120)	115 (138)	325 (308)	142 (269)
Price electricity (SEK/Kwh)	0.292 (0.126)	0.279 (0.080)	0.293 (0.093)	0.296 (0.096)	0.240 (0.087)	0.314 (0.096)
Price fossil fuel (SEK/Kwh)	0.282 (0.112)	0.286 (0.456)	0.341 (0.179)	0.359 (0.175)	0.235 (0.150)	0.494 (0.205)
CO_2 tax (SEK/Kg)	0.074 (0.068)	0.145 (0.063)	0.127 (0.078)	0.041 (0.064)	0.125 (0.070)	0.058 (0.076)
Nobs	193	2037	399	1800	1285	945

Note: Standard deviation in parenthesis

Table 2. Continuing

	Sector					
Variable	Chemical	Rubber/ plastic	Mineral/ stone	Steel /iron	Machine/ electro	Motor vehicles
Captal stock (TSEK)	631622 (1717444)	113645 (186114)	108487 (178253)	191806 (479269)	238416 (752930)	581917 (2155773)
Employees (number of)	214 (260)	140 (123)	129 (122)	190 (326)	228 (319)	466 (1062)
Price electricity (SEK/Kwh)	0.259 (0.105)	0.282 (0.074)	0.306 (0.096)	0.292 (0.086)	0.314 (0.093)	0.303 (0.091)
Price fossil fuel (SEK/Kwh)	0.272 (0.152)	0.369 (0.165)	0.235 (0.115)	0.314 (0.146)	0.395 (0.161)	0.137 (0.134)
CO_2 tax (SEK/Kg)	0.123 (0.079)	0.111 (0.081)	0.134 (0.065)	0.137 (0.069)	0.108 (0.078)	0.137 (0.065)
Nobs	974	917	1042	2753	3649	1098

Note: Standard deviation in parenthesis

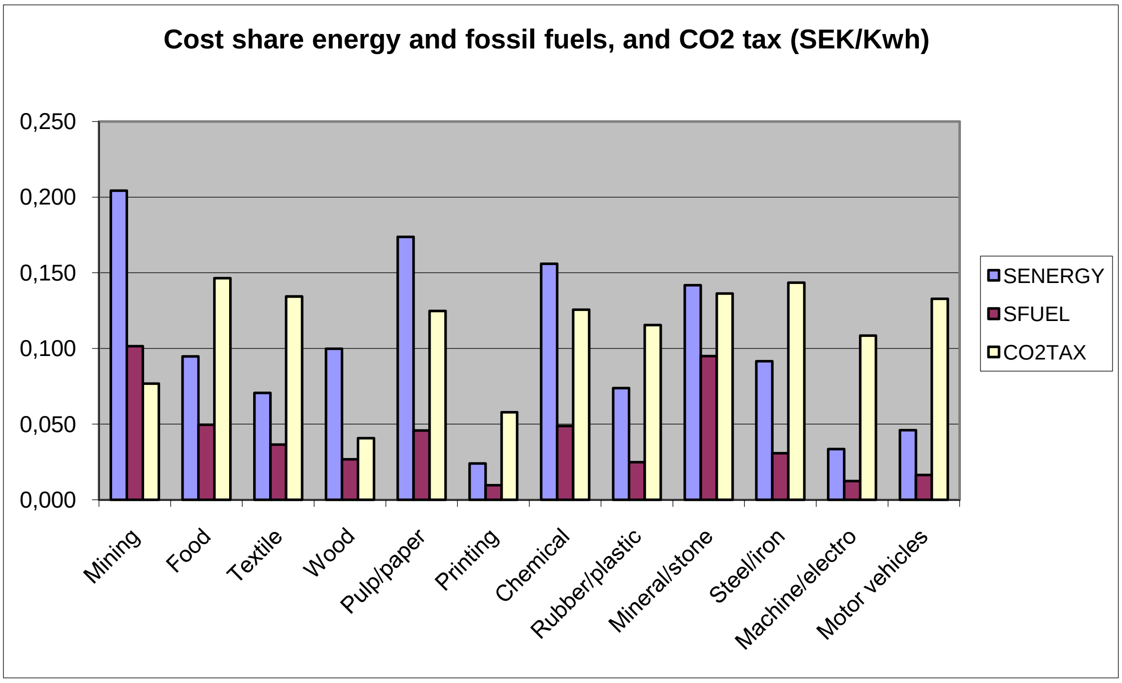

Figure 3. Input cost share for energy and fossil fuels, and CO_2 tax (SEK/Kwh)

5. Results

The results presented in this section counts for the Swedish manufacturing sector as a whole, the energy intensive sector, and the non-energy intensive sector. Estimations are also run on individual sectors separately (full estimation results are given in Appendix A). Two slightly different estimating approaches are behind the results. In Table 3a the results are based on modeling the quasi-fixed capital and labor variables as arguments in the profit function, i.e., equation (8), and in Table 3b the results are based on modeling these variables as arguments in the (in)efficiency function, i.e., equation (9). As the γ-columns reveal, independently of estimating approach, significant profit inefficiencies can be established for all sectors, except for Steel/Iron.

Table 3a. Summarizing results - capital (*K*) and labor (*L*) in profit function (equation (8)).

Sector	Static effect, δ_1	Dynamic effect, δ_2	Profit efficiency PE	$\gamma = \sigma^2_u/\sigma^2_\varepsilon$	$\sigma^2_{\varepsilon=v-u}$	Energy int.	Number of obs
Manufacturing	-***	-***	0.664	0.522***	0.401	Yes/no	13100
Energy int.	-***	-***	0.671	0.536***	0.479	Yes	7338
Non-energy int.	+*	+	0.716	0.605***	0.267	No	5762
Mining	+	+**	0.599	0.864***	0.265	Yes	141
Food	-	+*	0.269	0.864***	0.412	Yes	1493
Textile	+	+**	0.492	0.837***	0.254	No	277
Wood	-	-	0.568	0.964***	1.372	Yes	1298
Pulp/Paper	-**	-	0.635	0.561***	0.177	Yes	949
Printing	-	+*	0.660	0.551***	0.249	No	637
Chemical	-	-	0.633	0.339***	0.651	Yes	689
Rubber/Plastic	-	-	0.796	0.492**	0.182	No	644
Mineral/Stone	+	-*	0.749	0.480***	0.278	Yes	744
Steel/Iron			0.906	0.002	0.392	Yes	2030
Machine/Electro	+	-*	0.697	0.656***	0.263	No	2552
Motor vehicles	+***	-***	0.696	0.702***	0.215	No	1048

*Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table 3b. Summarizing results - capital (*K*) and labor (*L*) in (in)efficiency function (equation (9)).

Sector	Static effect, δ_1	Dynamic effect, δ_2	Profit efficiency PE	$\gamma = \sigma^2_u/\sigma^2_\varepsilon$	$\sigma^2_{\varepsilon=v-u}$	Energy intensive	Number of obs
Manufacturing	-***	-	0.583	0.575***	0.616	Yes/no	13217
Energy int.	-***	-***	0.150	0.228***	0.562	Yes	7406
Non-energy int.	+*	+	0.076	0.021***	0.362	No	5811
Mining	+	-	0.664	0.590***	0.335	Yes	141
Food	-	+	0.618	0.594***	0.652	Yes	1503
Textile	-	+***	0.297	0.836***	0.192	No	277
Wood	-**	-	0.620	0.654***	0.648	Yes	1301
Pulp/Paper	-**	-**	0.290	0.863***	0.199	Yes	951
Printing	+	+	0.717	0.498***	0.353	No	639
Chemical	+	+**	0.476	0.481***	0.568	Yes	620
Rubber/Plastic	+	-***	0.641	0.657***	0.306	No	642
Mineral/Stone	+***	-*	0.587	0.359**	0.255	Yes	787
Steel/Iron			0.076	0.000	0.412	Yes	2038
Machine/Electro	-	-	0.635	0.623***	0.440	No	2554
Motor vehicles	+*	-*	0.657	0.536***	0.468	No	821

Regarding estimated efficiency scores, the values vary considerably in levels, and between sectors. When modeling capital and labor as arguments in the profit function, Table 3a, the estimated average efficiency scores vary between individual sectors from 0.269 for Food to 0.796 for Rubber/Plastic. The corresponding figures with capital and labor as arguments in the (in)efficiency function, Table 3b, are 0.290 for Pulp and paper and 0.717 for printing. The interpretation is that the capacity of output production exceeded actual production during 1991-2004. The second approach which models capital and labor as arguments in the (in)efficiency function, as suggested by Lovell (1993), seem to work less well. For instance, the efficiency scores for the whole manufacturing sector, energy intensive sector, and non-energy intensive sector are 0.575, 0.150, and 0.076, respectively. The efficiency scores are unreasonable low for the energy intensive and non-energy intensive sectors compared to the manufacturing sector as a whole. Instead, as indicated in Table 3a, one should expect efficiency scores not to vary considerably on higher aggregation levels.[15] Therefore, hereafter we comment only on the results generated by the model where capital and labor variables are included as arguments in the profit function.[16]

The results indicate in general that manufacturing firms did not make efficient use of their technologies during the period in study and, therefore, did not maximize profits. The question is then whether the CO_2 tax scheme, introduced 1991, contributed positively to profit (in)efficiency during the period we study. For the manufacturing sector as a whole the result is very clear. The CO_2 tax had both negative static effects and negative dynamic effects on firm profit efficiency. This result contradicts the Porter hypothesis. Divided into subsectors, this conclusion still holds for the energy intensive sector. For the non-energy intensive sector, however, the result is in line with the Porter hypothesis, indicating that CO_2 taxation have positive effects on efficiency. Only the static effect is significant on the 10 percent level.

Turning to analyzing individual sectors, the results prove to vary substantially. Among the sectors Wood, Chemical, and Rubber/Plastic the CO_2 taxation did not have any effect on profit efficiency what so ever. A Porter effect appears among the sectors Mining, Food, Textile, and Printing. In these cases we identify positive dynamic effects of CO_2 taxation on profit efficiency. Notable is that when looking specifically on disaggregated data estimations

[15]The manufacturing sector is simply divided into energy intensive and non-energy intensive firms. This suggests that estimation of inefficiencies based on the sub-samples (energy intensive and non-energy intensive) should not differ so much from the estimated inefficiency based on the whole manufacturing sector.
[16] However, note that the results of both models, provided in Tables 3a and 3b, indicate similar static and dynamic effects of CO_2 taxation on profit efficiency.

(sectors), energy intensity of production seems to make little difference; Mining and Food being energy intensive, and Textile and Printing not being energy intensive. Interestingly, from the data section it is clear that the average tax paid by these four sectors was 0.101 SEK/kg emitted CO_2, which is slightly lower than the average of 0.11SEK/kg for all 12 sectors in study. There is no clear link between the level of average tax paid in a sector and the rejection or acceptance of the Porter argument.

In sum; the results are similar to those often achieved in previous studies. It is difficult to confirm any general effect of environmental regulation on productivity, in our case specifically profit efficiency. Therefore, the results provide no general evidence either for or against the Porter hypothesis. Instead, the results vary between sectors and aggregation levels.

6. Discussion and conclusions

The European Union advocates an ambitious climate policy strategy to address the anthropogenic climate change, and in a worldwide perspective the EU has the intention of setting a good example. According to the Porter hypothesis, the EU would benefit from such a strategy of being a 'first-mover' by applying the 'right kind' of environmental regulations. The hypothesis is controversial in some circles, and has been a subject of intensive research within the field of economics since the mid nineties. However, there are quite few studies that directly address the right kind of regulations, e.g., pollution taxes and tradable permits, and also address the effects of such regulations on firm profits. Furthermore, as far as we know, no study has concerned dynamic effects of CO_2 taxation on firms' profit efficiency before. In general, even though the dynamic perspective is the central message of the Porter hypothesis, it is very much left out in previous studies.

Considering the ‘first mover’ strategy of the EU, the main purpose of this paper has mainly been to assess the dynamic effects of the Swedish CO_2 tax scheme on firm profit efficiency in manufacturing during the period 1990 to 2004. The task has been accomplished by using a stochastic frontier approach.

The results are similar to those often presented in previous studies. It is difficult to confirm any general effect of environmental regulation on productivity, in our case specifically CO_2 taxation on firms’ profit efficiency. Therefore, the results provide no general evidence, neither for nor against the Porter hypothesis. On aggregated levels, manufacturing as a whole and the energy intensive sector show now positive response to taxation, while in the non-energy intensive sector results are less conclusive. Furthermore, the results vary between sub-sectors, and the estimations indicate positive dynamic effects within the Mining, Food, Textile, and Printing sectors.

Compared to other studies directing dynamic effects of environmental regulation on productivity, the results in this study is similar to those in Broberg et al. (2010). They find no general effect of investment in environmental protection on technical efficiency. However, the results differ from those in Lanoie et al. (2008). They find that investments in pollution control have positive dynamic effects on technological change in Quebec manufacturing in Canada. Also, they find that the positive dynamic effects are stronger in sectors which are more exposed to international competition. However, we do not confirm the latter finding. Our results indicate positive dynamic effects of CO_2 taxation on profit efficiency within four Swedish manufacturing sectors. Three of them are the same sectors as those in Quebec manufacturing that Lanoie et al. (2005) identify as less exposed to international competition, i.e., Food, Textile, and Printing.[17]

Furthermore, our study can be seen as a complement to Brännlund and Lundgren (2009). Using a sub-set of their data, the picture of the impact of CO_2 taxation on productivity in Swedish manufacturing is broadened. For energy intensive industries, due to negative effects on technological change, Brännlund and Lundgren (2009) find a negative impact of CO_2 taxation on profits. Taken together, no positive clear cut confirmation of the Porter hypothesis can be made regarding CO_2 taxation and its impact on profits.

The final and overall conclusion that can be made from this study is that we cannot confirm the hypothesis that the EU, or individual Member States, would benefit from being a 'first mover' in terms of imposing high CO_2 tax rates compared to other countries outside EU.

There are some interesting topics of future research. For instance, the EU attaches great importance to tradable permits by its Emission Trading System (ETS). The literature on environmental regulation and its impact on firm performance, in terms of giving incentives to productivity growth, is extensive but leaves out tradable permits. Another interesting topic would be to assess actual environmental performance on firm productivity and competitiveness. Simultaneously estimating the effect of CO_2 taxation on emission intensity and the effect of emission intensity on productivity would give an efficient estimate of the effect of environmental performance on productivity.

[17] Lanoie et al. (2005, p. 123) measures international competition as: exports + imports / total shipments. They find that the manufacturing sectors in Quebec, Canada, most exposed to international competition are Leather, Paper and allied products, Primary metals, Machinery, Transportation equipment, Electrical and electronic products, and Chemicals

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Appendix A

Table A1. Results with *K* and *L* in ”main” profit function as fixed inputs

Manufacturing

Parameter	Estimate	Error	t-statistic	P-value
A0	5.482	0.109	50.327	[.000]
A1	0.132	0.002	62.245	[.000]
A2	0.922	0.010	95.399	[.000]
A3	-0.047	0.008	-5.760	[.000]
A4	0.155	0.014	11.381	[.000]
DSIZE1	-0.059	0.024	-2.487	[.013]
DSIZE2	-0.046	0.018	-2.624	[.009]
DSIZE3	-0.046	0.017	-2.739	[.006]
AT1	0.192	0.030	6.295	[.000]
AT2	-0.020	0.003	-5.907	[.000]
AT3	0.001	0.000	6.527	[.000]
D0	-0.544	0.069	-7.832	[.000]
D1	**-0.500**	**0.229**	**-2.183**	**[.029]**
D2	**-0.600**	**0.237**	**-2.528**	**[.011]**
D3	0.000	0.000	3.895	[.000]
D5 (enint=1)	0.672	0.052	12.951	[.000]
DT	0.014	0.005	2.799	[.005]
GAMMA	0.522	0.013	38.821	[.000]
S2	0.401	0.012	33.300	[.000]
Nobs	13100			
Logl	-13323.000			
Schwarz BIC	13413.000			

Energy intensive industry

Parameter	Estimate	Error	t-statistic	P-value
A0	6.253	0.116	54.085	[.000]
A1	0.136	0.003	43.832	[.000]
A2	0.910	0.015	61.805	[.000]
A3	-0.003	0.011	-0.237	[.813]
A4	0.118	0.020	5.911	[.000]
DSIZE1	-0.018	0.036	-0.488	[.625]
DSIZE2	0.032	0.028	1.145	[.252]
DSIZE3	-0.031	0.025	-1.220	[.223]
AT1	-0.017	0.011	-1.526	[.127]
AT2	0.002	0.001	4.364	[.000]
D0	0.063	0.205	0.307	[.759]
D1	-0.546	0.391	-1.398	[.162]
D2	**-1.504**	**0.429**	**-3.504**	**[.000]**
D3	0.000	0.000	1.412	[.158]
DT	0.010	0.009	1.154	[.248]
GAMMA	0.536	0.022	24.101	[.000]
S2	0.479	0.030	15.838	[.000]
Nobs	7338			
Logl	-8123.930			
Schwarz BIC	8199.580			

Non-energy intensive industry

Parameter	Estimate	Error	t-statistic	P-value
A0	5.110	0.124	41.053	[.000]
A1	0.100	0.003	38.942	[.000]
A2	1.041	0.011	97.785	[.000]
A3	0.054	0.012	4.593	[.000]
A4	0.182	0.015	12.397	[.000]
DSIZE1	-0.034	0.026	-1.329	[.184]
DSIZE2	-0.076	0.019	-4.043	[.000]
DSIZE3	-0.070	0.019	-3.596	[.000]
AT1	0.168	0.036	4.721	[.000]
AT2	-0.016	0.004	-3.906	[.000]
AT3	0.001	0.000	4.290	[.000]
D0	-0.192	0.092	-2.081	[.037]
D1	**0.454**	**0.242**	**1.877**	**[.061]**
D2	0.290	0.240	1.211	[.226]
D3	0.000	0.000	-0.014	[.989]
DT	0.007	0.006	1.106	[.269]
GAMMA	0.605	0.014	43.966	[.000]
S2	0.267	0.010	26.556	[.000]
Nobs	5762			
Logl	-4672.180			
Schwarz BIC	4750.110			

Mining

Parameter	Estimate	Error	t-statistic	P-value
A0	8.441	1.650	5.116	[.000]
A1	-0.012	0.032	-0.376	[.707]
A2	1.014	0.075	13.508	[.000]
A3	-0.283	0.093	-3.038	[.002]
A4	-0.120	0.109	-1.102	[.271]
DSIZE1	0.717	0.217	3.305	[.001]
DSIZE2	0.448	0.151	2.970	[.003]
DSIZE3	0.228	0.187	1.219	[.223]
AT1	-0.434	0.443	-0.981	[.327]
AT2	0.018	0.042	0.430	[.667]
AT3	0.000	0.001	0.059	[.953]
D0	-3.553	0.744	-4.772	[.000]
D1	0.990	1.972	0.502	[.616]
D2	**4.906**	**2.213**	**2.216**	**[.027]**
D3	0.005	0.020	0.229	[.819]
DT	0.328	0.096	3.417	[.001]
GAMMA	0.864	0.068	12.778	[.000]
S2	0.265	0.056	4.741	[.000]
Nobs	141			
Logl	-53.276			
Schwarz BIC	97.815			

Food

Parameter	Estimate	Error	t-statistic	P-value
A0	6.544	0.795	8.226	[.000]
A1	0.106	0.010	10.850	[.000]
A2	0.906	0.054	16.939	[.000]
A3	-0.118	0.046	-2.585	[.010]
A4	-0.211	0.073	-2.903	[.004]
DSIZE1	-0.047	0.138	-0.337	[.736]
DSIZE2	-0.057	0.119	-0.478	[.633]
DSIZE3	-0.067	0.106	-0.634	[.526]
AT1	0.416	0.155	2.683	[.007]
AT2	-0.055	0.016	-3.342	[.001]
AT3	0.002	0.001	3.561	[.000]
D0	-1.662	0.587	-2.831	[.005]
D1	-0.620	0.469	-1.323	[.186]
D2	**0.839**	**0.475**	**1.764**	**[.078]**
D3	-0.062	0.032	-1.967	[.049]
DT	0.031	0.046	0.666	[.505]
GAMMA	0.864	0.148	5.838	[.000]
S2	0.412	0.017	24.041	[.000]
Nobs	1493			
Logl	-1417.420			
Schwarz BIC	1483.190			

Textile

Parameter	Estimate	Error	t-statistic	P-value
A0	5.906	1.230	4.801	[.000]
A1	0.118	0.017	7.150	[.000]
A2	0.443	0.202	2.192	[.028]
A3	0.137	0.084	1.636	[.102]
A4	-0.297	0.115	-2.594	[.009]
DSIZE1	0.594	0.314	1.889	[.059]
DSIZE2	0.420	0.237	1.775	[.076]
DSIZE3	0.559	0.175	3.194	[.001]
AT1	0.792	0.242	3.279	[.001]
AT2	-0.103	0.028	-3.688	[.000]
AT3	0.004	0.001	3.995	[.000]
D0	-2.384	0.393	-6.071	[.000]
D1	0.182	1.390	0.131	[.896]
D2	**3.572**	**1.473**	**2.426**	**[.015]**
D3	0.684	0.198	3.457	[.001]
DT	0.030	0.019	1.567	[.117]
GAMMA	0.837	0.081	10.347	[.000]
S2	0.254	0.031	8.123	[.000]
Nobs	277			
Logl	-152.586			
Schwarz BIC	203.203			

Wood

Parameter	Estimate	Error	t-statistic	P-value
A0	6.059	0.393	15.416	[.000]
A1	0.092	0.008	11.075	[.000]
A2	0.802	0.034	23.479	[.000]
A3	0.017	0.044	0.391	[.696]
A4	0.063	0.057	1.098	[.272]
DSIZE1	0.581	0.094	6.151	[.000]
DSIZE2	0.726	0.078	9.293	[.000]
DSIZE3	0.653	0.083	7.863	[.000]
AT1	0.250	0.114	2.186	[.029]
AT2	-0.015	0.013	-1.187	[.235]
AT3	0.000	0.000	0.761	[.447]
D0	1.081	0.792	1.365	[.172]
D1	-2.662	1.686	-1.579	[.114]
D2	-1.027	1.741	-0.590	[.555]
D3	0.077	0.108	0.711	[.477]
DT	-0.034	0.033	-1.025	[.305]
GAMMA	0.954	0.011	86.705	[.000]
S2	1.372	0.363	3.780	[.000]
Nobs	1298			
Logl	-1137.040			
Schwarz BIC	1201.560			

Pulp/paper

Parameter	Estimate	Error	t-statistic	P-value
A0	9.827	1.516	6.483	[.000]
A1	0.102	0.012	8.380	[.000]
A2	0.880	0.036	24.635	[.000]
A3	-0.100	0.026	-3.832	[.000]
A4	-0.288	0.054	-5.371	[.000]
DSIZE1	-0.250	0.077	-3.263	[.001]
DSIZE2	-0.160	0.053	-3.001	[.003]
DSIZE3	-0.198	0.045	-4.384	[.000]
AT1	-0.555	0.473	-1.174	[.240]
AT2	0.009	0.044	0.213	[.831]
AT3	0.001	0.001	0.606	[.544]
D0	-3.208	0.636	-5.046	[.000]
D1	**-1.520**	**0.654**	**-2.325**	**[.020]**
D2	-0.173	0.709	-0.243	[.808]
D3	-0.013	0.008	-1.591	[.112]
DT	0.360	0.100	3.616	[.000]
GAMMA	0.561	0.063	8.933	[.000]
S2	0.177	0.017	10.362	[.000]
Nobs	949			
Logl	-349.692			
Schwarz BIC	406.391			

Printing

Parameter	Estimate	Error	t-statistic	P-value
A0	6.202	0.664	9.340	[.000]
A1	0.107	0.011	9.564	[.000]
A2	0.862	0.041	20.995	[.000]
A3	-0.223	0.069	-3.244	[.001]
A4	-0.165	0.067	-2.451	[.014]
DSIZE1	-0.190	0.133	-1.433	[.152]
DSIZE2	-0.126	0.119	-1.060	[.289]
DSIZE3	-0.116	0.144	-0.806	[.420]
AT1	-0.088	0.177	-0.493	[.622]
AT2	-0.005	0.018	-0.262	[.793]
AT3	0.000	0.001	0.785	[.432]
D0	-1.296	0.352	-3.683	[.000]
D1	-1.321	1.091	-1.211	[.226]
D2	**2.080**	**1.068**	**1.947**	**[.051]**
D3	-0.022	0.047	-0.476	[.634]
DT	0.114	0.039	2.898	[.004]
GAMMA	0.551	0.094	5.844	[.000]
S2	0.249	0.029	8.512	[.000]
Nobs	637			
Logl	-367.162			
Schwarz BIC	425.273			

Chemical

Parameter	Estimate	Error	t-statistic	P-value
A0	11.308	2.987	3.786	[.000]
A1	0.174	0.022	7.845	[.000]
A2	0.887	0.064	13.843	[.000]
A3	-0.131	0.039	-3.314	[.001]
A4	0.147	0.088	1.676	[.094]
DSIZE1	0.258	0.174	1.484	[.138]
DSIZE2	0.242	0.126	1.925	[.054]
DSIZE3	0.352	0.129	2.726	[.006]
AT1	-1.051	0.893	-1.177	[.239]
AT2	0.043	0.087	0.496	[.620]
AT3	0.000	0.003	0.037	[.971]
D0	-4.926	1.457	-3.381	[.001]
D1	-0.632	0.980	-0.645	[.519]
D2	-1.302	1.092	-1.192	[.233]
D3	0.121	0.036	3.342	[.001]
DT	0.569	0.221	2.577	[.010]
GAMMA	0.339	0.131	2.596	[.009]
S2	0.651	0.107	6.103	[.000]
Nobs	689			
Logl	-749.928			
Schwarz BIC	808.746			

Rubber/plastic

Parameter	Estimate	Error	t-statistic	P-value
A0	5.405	0.384	14.077	[.000]
A1	0.087	0.008	10.350	[.000]
A2	1.002	0.046	21.571	[.000]
A3	0.032	0.036	0.885	[.376]
A4	0.014	0.054	0.265	[.791]
DSIZE1	-0.046	0.093	-0.491	[.624]
DSIZE2	-0.126	0.074	-1.709	[.088]
DSIZE3	-0.041	0.055	-0.748	[.454]
AT1	0.100	0.100	0.997	[.319]
AT2	-0.012	0.011	-1.108	[.268]
AT3	0.001	0.000	1.423	[.155]
D0	0.019	0.839	0.023	[.982]
D1	-0.108	0.809	-0.134	[.893]
D2	-0.953	1.876	-0.508	[.612]
D3	-0.031	0.059	-0.522	[.602]
DT	0.018	0.033	0.531	[.595]
GAMMA	0.492	0.232	2.124	[.034]
S2	0.182	0.107	1.696	[.090]
Nobs	644			
Logl	-398.036			
Schwarz BIC	456.245			

Mineral/stone

Parameter	Estimate	Error	t-statistic	P-value
A0	10.092	1.779	5.672	[.000]
A1	0.121	0.013	9.094	[.000]
A2	0.794	0.037	21.584	[.000]
A3	-0.033	0.026	-1.280	[.201]
A4	-0.063	0.048	-1.295	[.195]
DSIZE1	-0.139	0.091	-1.532	[.126]
DSIZE2	-0.168	0.072	-2.345	[.019]
DSIZE3	-0.212	0.065	-3.255	[.001]
AT1	-0.902	0.446	-2.021	[.043]
AT2	0.057	0.038	1.506	[.132]
AT3	-0.001	0.001	-0.857	[.391]
D0	-2.934	0.958	-3.062	[.002]
D1	0.850	1.836	0.463	[.643]
D2	**-3.668**	**1.933**	**-1.897**	**[.058]**
D3	-0.017	0.034	-0.514	[.607]
DT	0.434	0.111	3.915	[.000]
GAMMA	0.480	0.078	6.144	[.000]
S2	0.278	0.029	9.648	[.000]
Nobs	744			
Logl	-442.891			
Schwarz BIC	502.755			

Steel/iron

Parameter	Estimate	Error	t-statistic	P-value
A0	7.405	1.612	4.595	[.000]
A1	0.119	0.009	12.841	[.000]
A2	0.907	0.043	21.272	[.000]
A3	-0.327	0.027	-12.235	[.000]
A4	-0.293	0.063	-4.647	[.000]
DSIZE1	-0.271	0.100	-2.721	[.006]
DSIZE2	-0.182	0.071	-2.560	[.010]
DSIZE3	-0.129	0.068	-1.882	[.060]
AT1	-0.762	0.427	-1.785	[.074]
AT2	0.069	0.038	1.816	[.069]
AT3	-0.002	0.001	-1.674	[.094]
D0	-1.110	0.928	-1.197	[.231]
D1	**-2.541**	**0.912**	**-2.788**	**[.005]**
D2	**2.265**	**0.878**	**2.579**	**[.010]**
D3	-0.014	0.009	-1.491	[.136]
DT	0.173	0.129	1.341	[.180]
GAMMA	0.002	0.021	0.099	[.921]
S2	0.396	0.012	32.443	[.000]
Nobs	2030			
Logl	-1939.920			
Schwarz BIC	2008.460			

Machine/electro

Parameter	Estimate	Error	t-statistic	P-value
A0	4.877	0.170	28.639	[.000]
A1	0.092	0.004	23.580	[.000]
A2	1.077	0.016	68.624	[.000]
A3	-0.116	0.012	9.849	[.000]
A4	-0.144	0.021	6.981	[.000]
DSIZE1	0.028	0.040	0.706	[.480]
DSIZE2	0.055	0.027	2.038	[.042]
DSIZE3	0.001	0.027	0.043	[.965]
AT1	0.225	0.051	4.407	[.000]
AT2	-0.023	0.006	-3.957	[.000]
AT3	0.001	0.000	4.430	[.000]
D0	-0.069	0.130	-0.531	[.595]
D1	0.487	0.344	1.416	[.157]
D2	**-0.640**	**0.378**	**-1.693**	**[.090]**
D3	-0.011	0.005	-2.125	[.034]
DT	0.005	0.008	0.665	[.506]
GAMMA	0.656	0.018	36.306	[.000]
S2	0.263	0.013	19.915	[.000]
Nobs	2552			
Logl	-2100.930			
Schwarz BIC	2171.500			

Motor vehicles

Parameter	Estimate	Error	t-statistic	P-value
A0	5.088	0.274	18.539	[.000]
A1	0.074	0.006	12.301	[.000]
A2	1.004	0.022	45.718	[.000]
A3	0.069	0.030	2.301	[.021]
A4	0.057	0.035	1.600	[.110]
DSIZE1	-0.340	0.051	-6.708	[.000]
DSIZE2	-0.411	0.039	-10.548	[.000]
DSIZE3	-0.403	0.049	-8.239	[.000]
AT1	0.442	0.081	5.436	[.000]
AT2	-0.046	0.009	-4.956	[.000]
AT3	0.002	0.000	4.912	[.000]
D0	-0.088	0.174	-0.505	[.614]
D1	**1.520**	**0.422**	**3.601**	**[.000]**
D2	**-2.362**	**0.478**	**-4.937**	**[.000]**
D3	0.001	0.003	0.407	[.684]
DT	0.011	0.012	0.950	[.342]
GAMMA	0.702	0.026	26.593	[.000]
S2	0.215	0.018	12.121	[.000]
Nobs	1048			
Logl	-775.229			
Schwarz BIC	837.821			

Table A2. Results with *K* and *L* in inefficiency equation

Manufacturing

Parameter	Estimate	Error	t-statistic	P-value
A0	12.695	0.114	111.414	[.000]
A1	-0.084	0.010	-8.621	[.000]
A2	0.028	0.016	1.715	[.086]
DSIZE1	-2.531	0.023	-109.516	[.000]
DSIZE2	-1.598	0.022	-74.335	[.000]
DSIZE3	-1.024	0.022	-46.686	[.000]
AT1	0.273	0.037	7.323	[.000]
AT2	-0.027	0.004	-6.315	[.000]
AT3	0.001	0.000	6.389	[.000]
D0	-0.611	0.081	-7.517	[.000]
D1	**-0.707**	**0.247**	**-2.856**	**[.004]**
D2	-0.370	0.252	-1.466	[.143]
D3	0.000	0.000	3.656	[.000]
D4	0.000	0.000	2.556	[.011]
D5 (enint=1)	0.678	0.047	14.529	[.000]
DT	0.003	0.005	0.637	[.524]
GAMMA	0.575	0.012	47.522	[.000]
S2	0.616	0.019	32.294	[.000]
Nobs	13217			
Logl	-16420.900			
Schwarz BIC	16506.300			

Energy intensive industry

Parameter	Estimate	Error	t-statistic	P-value
A0	12.692	0.218	58.118	[.000]
A1	-0.027	0.018	-1.530	[.126]
A2	-0.009	0.028	-0.326	[.744]
DSIZE1	1.760	0.140	12.573	[.000]
DSIZE2	1.748	0.109	16.084	[.000]
DSIZE3	0.916	0.077	11.821	[.000]
AT1	0.291	0.073	3.966	[.000]
AT2	-0.034	0.008	-4.080	[.000]
AT3	0.001	0.000	4.372	[.000]
D0	-5.294	0.180	-29.487	[.000]
D1	**-0.677**	**0.221**	**-3.063**	**[.002]**
D2	**-0.960**	**0.234**	**-4.110**	**[.000]**
D3	0.012	0.001	23.134	[.000]
D4	0.000	0.000	12.027	[.000]
DT	0.010	0.009	1.140	[.254]
GAMMA	0.228	0.051	4.436	[.000]
S2	0.562	0.011	50.226	[.000]
Nobs	7406			
Logl	-8232.550			
Schwarz BIC	8308.290			

Non-energy intensive industry

Parameter	Estimate	Error	t-statistic	P-value
A0	13.336	0.278	48.040	[.000]
A1	0.061	0.023	2.677	[.007]
A2	0.166	0.030	5.602	[.000]
DSIZE1	-0.105	0.112	-0.932	[.351]
DSIZE2	0.423	0.090	4.693	[.000]
DSIZE3	0.495	0.064	7.750	[.000]
AT1	0.260	0.070	3.742	[.000]
AT2	-0.019	0.008	-2.489	[.013]
AT3	0.001	0.000	2.317	[.021]
D0	-3.902	0.215	-18.178	[.000]
D1	**0.341**	**0.207**	**1.650**	**[.099]**
D2	0.094	0.206	0.455	[.649]
D3	0.005	0.000	16.399	[.000]
D4	0.000	0.000	9.116	[.000]
DT	-0.036	0.021	-1.752	[.080]
GAMMA	0.021	0.003	6.283	[.000]
S2	0.362	0.009	38.265	[.000]
Nobs	5811			
Logl	-5287.000			
Schwarz BIC	5360.680			

Mining

Parameter	Estimate	Error	t-statistic	P-value
A0	9.028	1.168	7.729	[.000]
A1	-0.997	0.135	-7.391	[.000]
A2	-0.701	0.138	-5.081	[.000]
DSIZE1	-2.105	0.265	-7.950	[.000]
DSIZE2	-0.811	0.251	-3.231	[.001]
DSIZE3	-0.444	0.234	-1.896	[.058]
AT1	0.319	0.369	0.864	[.388]
AT2	-0.028	0.041	-0.684	[.494]
AT3	0.001	0.001	0.627	[.531]
D0	-0.101	1.156	-0.088	[.930]
D1	0.768	2.099	0.366	[.714]
D2	-2.666	3.985	-0.669	[.504]
D3	0.001	0.002	0.331	[.740]
D4	0.000	0.000	0.061	[.951]
DT	-0.010	0.067	-0.146	[.884]
GAMMA	0.590	0.166	3.550	[.000]
S2	0.335	0.187	1.787	[.074]
Nobs	141			
Logl	-132.183			
Schwarz BIC	174.247			

Food

Parameter	Estimate	Error	t-statistic	P-value
A0	11.766	0.391	30.091	[.000]
A1	-0.160	0.044	-3.625	[.000]
A2	-0.220	0.070	-3.160	[.002]
DSIZE1	-0.821	0.093	-8.812	[.000]
DSIZE2	-0.755	0.058	-13.058	[.000]
DSIZE3	-0.512	0.052	-9.894	[.000]
AT1	0.354	0.139	2.546	[.011]
AT2	-0.044	0.016	-2.714	[.007]
AT3	0.002	0.001	2.945	[.003]
D0	-2.410	0.188	-12.830	[.000]
D1	-0.457	0.891	-0.513	[.608]
D2	1.062	0.964	1.101	[.271]
D3	0.014	0.001	12.701	[.000]
D4	0.000	0.000	5.327	[.000]
DT	-0.016	0.014	-1.086	[.277]
GAMMA	0.594	0.046	13.014	[.000]
S2	0.652	0.047	13.942	[.000]
Nobs	1503			
Logl	-1443.300			
Schwarz BIC	1505.48			

Textile

Parameter	Estimate	Error	t-statistic	P-value
A0	10.124	0.623	16.262	[.000]
A1	0.155	0.050	3.107	[.002]
A2	-0.227	0.118	-1.927	[.054]
DSIZE1	0.324	0.168	1.922	[.055]
DSIZE2	0.270	0.119	2.261	[.024]
DSIZE3	0.269	0.090	3.004	[.003]
AT1	0.766	0.205	3.745	[.000]
AT2	-0.094	0.024	-3.869	[.000]
AT3	0.004	0.001	4.134	[.000]
D0	-3.055	0.227	-13.466	[.000]
D1	-0.056	0.793	-0.070	[.944]
D2	**3.634**	**0.834**	**4.358**	**[.000]**
D3	0.007	0.001	7.339	[.000]
D4	0.000	0.000	8.224	[.000]
DT	-0.031	0.018	-1.713	[.087]
GAMMA	0.836	0.054	15.564	[.000]
S2	0.192	0.024	8.030	[.000]
Nobs	277			
Logl	-131.488			
Schwarz BIC	179.292			

Wood

Parameter	Estimate	Error	t-statistic	P-value
A0	11.234	0.428	26.249	[.000]
A1	0.030	0.051	0.593	[.553]
A2	0.010	0.048	0.218	[.828]
DSIZE1	-0.669	0.106	-6.284	[.000]
DSIZE2	-0.310	0.106	-2.925	[.003]
DSIZE3	-0.219	0.125	-1.745	[.081]
AT1	0.455	0.140	3.243	[.001]
AT2	-0.043	0.016	-2.715	[.007]
AT3	0.001	0.001	2.484	[.013]
D0	-2.452	0.238	-10.298	[.000]
D1	**-1.798**	**0.867**	**-2.072**	**[.038]**
D2	-0.750	0.886	-0.846	[.398]
D3	0.016	0.003	6.093	[.000]
D4	0.000	0.000	5.234	[.000]
DT	0.025	0.017	1.442	[.149]
GAMMA	0.654	0.074	8.878	[.000]
S2	0.648	0.100	6.452	[.000]
Nobs	1301			
Logl	-1190.330			
Schwarz BIC	1251.280			

Pulp/paper

Parameter	Estimate	Error	t-statistic	P-value
A0	13.071	0.256	51.120	[.000]
A1	-0.072	0.024	-2.961	[.003]
A2	-0.279	0.047	-5.937	[.000]
DSIZE1	-0.390	0.133	-2.944	[.003]
DSIZE2	0.230	0.108	2.124	[.034]
DSIZE3	0.313	0.097	3.220	[.001]
AT1	0.154	0.087	1.775	[.076]
AT2	-0.021	0.010	-2.098	[.036]
AT3	0.001	0.000	2.539	[.011]
D0	-2.930	0.157	-18.624	[.000]
D1	**-0.757**	**0.370**	**-2.045**	**[.041]**
D2	**-0.938**	**0.396**	**-2.368**	**[.018]**
D3	0.004	0.000	15.371	[.000]
D4	0.000	0.000	7.285	[.000]
DT	0.005	0.007	0.651	[.515]
GAMMA	0.863	0.021	41.291	[.000]
S2	0.199	0.010	20.932	[.000]
Nobs	951			
Logl	-423.837			
Schwarz BIC	482.125			

Printing

Parameter	Estimate	Error	t-statistic	P-value
A0	11.391	0.439	25.937	[.000]
A1	-0.134	0.051	-2.618	[.009]
A2	-0.254	0.074	-3.411	[.001]
DSIZE1	-1.629	0.123	-13.203	[.000]
DSIZE2	-1.181	0.111	-10.658	[.000]
DSIZE3	-0.674	0.120	-5.622	[.000]
AT1	0.062	0.158	0.393	[.694]
AT2	-0.011	0.018	-0.613	[.540]
AT3	0.001	0.001	0.915	[.360]
D0	-2.211	0.220	-10.054	[.000]
D1	0.863	0.922	0.936	[.349]
D2	1.339	0.995	1.346	[.178]
D3	0.022	0.004	6.123	[.000]
D4	0.000	0.000	3.850	[.000]
DT	-0.018	0.019	-0.940	[.347]
GAMMA	0.498	0.080	6.211	[.000]
S2	0.353	0.048	7.380	[.000]
Nobs	639			
Logl	-431.083			
Schwarz BIC	485.992			

Chemical

Parameter	Estimate	Error	t-statistic	P-value
A0	12.010	0.688	17.468	[.000]
A1	-0.106	0.034	-3.089	[.002]
A2	0.081	0.087	0.932	[.351]
DSIZE1	-1.461	0.211	-6.919	[.000]
DSIZE2	-0.894	0.131	-6.841	[.000]
DSIZE3	-0.605	0.123	-4.905	[.000]
AT1	0.548	0.232	2.358	[.018]
AT2	-0.065	0.026	-2.496	[.013]
AT3	0.002	0.001	2.702	[.007]
D0	-1.901	0.324	-5.874	[.000]
D1	1.082	0.739	1.463	[.143]
D2	**2.145**	**0.910**	**2.358**	**[.018]**
D3	0.002	0.001	1.448	[.148]
D4	0.000	0.000	2.692	[.007]
DT	-0.025	0.026	-0.926	[.354]
GAMMA	0.481	0.134	3.580	[.000]
S2	0.568	0.085	6.676	[.000]
Nobs	620			
Logl	-636.122			
Schwarz BIC	690.775			

Rubber/plastic

Parameter	Estimate	Error	t-statistic	P-value
A0	12.271	0.333	36.863	[.000]
A1	0.172	0.037	4.585	[.000]
A2	-0.043	0.059	-0.724	[.469]
DSIZE1	-1.929	0.068	-28.523	[.000]
DSIZE2	-1.226	0.060	-20.363	[.000]
DSIZE3	-0.498	0.055	-8.977	[.000]
AT1	0.201	0.116	1.734	[.083]
AT2	-0.016	0.013	-1.244	[.213]
AT3	0.000	0.000	1.070	[.285]
D0	-0.308	0.243	-1.267	[.205]
D1	0.869	0.671	1.297	[.195]
D2	**-2.511**	**0.873**	**-2.876**	**[.004]**
D3	0.002	0.001	2.965	[.003]
D4	0.000	0.000	0.648	[.517]
DT	0.000	0.016	0.018	[.986]
GAMMA	0.657	0.055	12.038	[.000]
S2	0.306	0.040	7.589	[.000]
Nobs	642			
Logl	-600.380			
Schwarz BIC	655.329			

Mineral/stone

Parameter	Estimate	Error	t-statistic	P-value
A0	11.313	0.424	26.661	[.000]
A1	0.001	0.035	0.036	[.971]
A2	-0.161	0.057	-2.822	[.005]
DSIZE1	-0.960	0.174	-5.509	[.000]
DSIZE2	-1.026	0.148	-6.934	[.000]
DSIZE3	-0.716	0.072	-9.991	[.000]
AT1	0.243	0.157	1.552	[.121]
AT2	-0.030	0.018	-1.741	[.082]
AT3	0.001	0.001	2.108	[.035]
D0	-2.340	0.158	-14.818	[.000]
D1	**1.555**	**0.515**	**3.021**	**[.003]**
D2	**-0.923**	**0.560**	**-1.648**	**[.099]**
D3	0.015	0.002	6.254	[.000]
D4	0.000	0.000	4.124	[.000]
DT	-0.010	0.014	-0.753	[.452]
GAMMA	0.359	0.180	1.992	[.046]
S2	0.255	0.034	7.526	[.000]
Nobs	787			
Logl	-493.588			
Schwarz BIC	550.268			

Steel/iron

Parameter	Estimate	Error	t-statistic	P-value
A0	12.650	0.358	35.385	[.000]
A1	-0.433	0.043	-10.142	[.000]
A2	-0.253	0.064	-3.958	[.000]
DSIZE1	1.336	0.205	6.520	[.000]
DSIZE2	1.354	0.155	8.719	[.000]
DSIZE3	0.757	0.111	6.845	[.000]
AT1	-0.191	0.125	-1.531	[.126]
AT2	0.020	0.014	1.471	[.141]
AT3	-0.001	0.000	-1.105	[.269]
D0	-4.657	0.272	-17.138	[.000]
D1	**-1.558**	**0.463**	**-3.362**	**[.001]**
D2	0.321	0.473	0.679	[.497]
D3	0.010	0.001	15.831	[.000]
D4	0.000	0.000	14.690	[.000]
DT	-0.005	0.011	-0.427	[.669]
GAMMA	0.000	0.022	0.022	[.983]
S2	0.412	0.009	44.925	[.000]
Nobs	2038			
Logl	-1987.980			
Schwarz BIC	2052.750			

Machine/electro

Parameter	Estimate	Error	t-statistic	P-value
A0	12.479	0.219	56.962	[.000]
A1	0.104	0.020	5.214	[.000]
A2	0.175	0.029	6.092	[.000]
DSIZE1	-2.605	0.053	-48.772	[.000]
DSIZE2	-1.606	0.043	-37.575	[.000]
DSIZE3	-1.046	0.042	-25.184	[.000]
AT1	0.375	0.070	5.335	[.000]
AT2	-0.034	0.008	-4.297	[.000]
AT3	0.001	0.000	4.099	[.000]
D0	-0.164	0.176	-0.929	[.353]
D1	-0.377	0.444	-0.848	[.396]
D2	-0.009	0.464	-0.020	[.984]
D3	0.000	0.000	1.481	[.139]
D4	0.000	0.000	0.902	[.367]
DT	-0.002	0.011	-0.165	[.869]
GAMMA	0.623	0.022	28.910	[.000]
S2	0.440	0.027	16.377	[.000]
Nobs	2554			
Logl	-2744.760			
Schwarz BIC	2811.450			

Motor vehicles

Parameter	Estimate	Error	t-statistic	P-value
A0	12.473	0.465	26.824	[.000]
A1	-0.073	0.038	-1.933	[.053]
A2	0.133	0.062	2.132	[.033]
DSIZE1	-3.405	0.097	-35.164	[.000]
DSIZE2	-2.680	0.096	-27.811	[.000]
DSIZE3	-1.978	0.122	-16.249	[.000]
AT1	0.542	0.137	3.964	[.000]
AT2	-0.050	0.015	-3.213	[.001]
AT3	0.002	0.001	2.919	[.004]
D0	-0.073	0.538	-0.135	[.892]
D1	**1.696**	**0.881**	**1.924**	**[.054]**
D2	**-2.156**	**1.187**	**-1.816**	**[.069]**
D3	0.000	0.000	0.596	[.551]
D4	0.000	0.000	-0.005	[.996]
DT	-0.006	0.020	-0.299	[.765]
GAMMA	0.536	0.069	7.769	[.000]
S2	0.468	0.088	5.291	[.000]
Nobs	821			
Logl	-913.157			
Schwarz BIC	970.197			